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NATIONAL DAM INSPECTION PROGRAM. COKEBURG WATER SUPPLY DAM (NDI--ETC(U)
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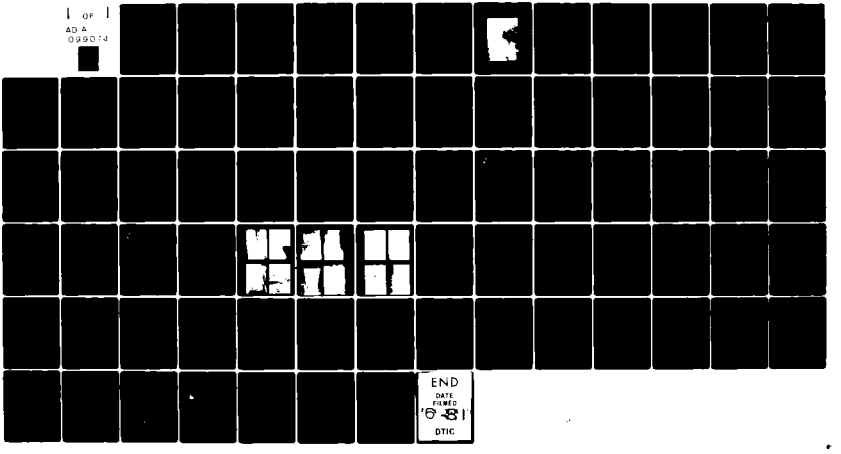


OHIO RIVER BASIN

TRIBUTARY SOUTH BRANCH PIGEON CREEK, WASHINGTON COUNTY

PENNSYLVANIA

COKEBURG WATER SUPPLY DAM

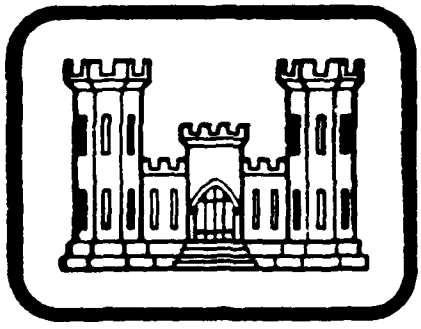
NDI ID NO. PA-1094

DER ID NO. 63-30

BOROUGH OF COKEBURG

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM



Prepared By

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EBENSBURG, PENNSYLVANIA
15931

DACW31-81-C-0012

FOR

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT CORPS OF ENGINEERS
BALTIMORE, MARYLAND
21203

APRIL, 1980

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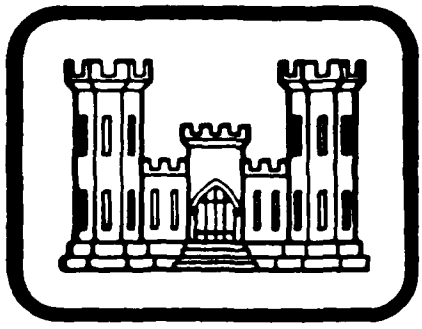

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in detemining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I REPORT
NATIONAL DAM INSPECTION REPORT

NAME OF DAM	Cokeburg Water Supply Dam
STATE LOCATED	Pennsylvania
COUNTY LOCATED	Washington
STREAM	Tributary to the South Branch of Pigeon Creek
DATE OF INSPECTION	November 5, 1980
COORDINATES	Lat: 40° 5.9' Long: 80° 4.2'

ASSESSMENT

The assessment of Cokeburg Water Supply Dam is based upon visual observations made at the time of inspection, review of available data, hydraulic and hydrologic computations and past operational performance of the structure. The inspection and review of data of the Cokeburg Water Supply Dam revealed that further investigations of the magnitude of a Phase II are required. The inspection did not reveal any problems which require immediate emergency action. The dam appears to be in poor condition and poorly maintained. The structure is classified as unsafe, non-emergency.

The stability of the structure is questionable due to the existence of coke ovens in the downstream slope of the embankment and failure of the discharge culvert outlet. Considerable erosion and/or settlement has occurred near the outlet of the spillway discharge culvert. The interior walls of the culvert, at the outlet are caving in and debris partially blocks the outlet. Portions of the reservoir slopes may contain coal refuse, which could lead to potential landslides affecting the storage and volume of the reservoir. During periods of heavy precipitation a potential landslide could occur, increasing the possibility for overtopping of the structure.

The Cokeburg Water Supply Dam is a high hazard-small size dam. The Spillway Design Flood (SDF) for a dam of this size and classification is in the range of 1/2 PMF to the PMF. The PMF has been selected as the spillway design flood based on the downstream potential for loss of life and property damage. The spillway and reservoir are capable of controlling less than 30% of the PMF without overtopping the embankment low spot. Results of the dam breach analysis indicate that downstream damages would be significantly increased due to dam failure. The spillway is termed seriously inadequate. The dam is classified as an unsafe, non-emergency structure.

COKEBURG WATER SUPPLY DAM
PA 1094

The following recommendations and remedial measures should be instituted immediately.

1. A detailed stability and seepage analysis should be conducted by a registered professional engineer knowledgeable in dam design and construction and should be conducted in conjunction with a detailed hydraulic and hydrologic analysis of the structure to increase the spillway capacity and to document the stability of the structure.

2. The fence which surrounds the inlet for the spillway should be removed. The location and type of fence is such that it may reduce the spillway capacity by collecting debris. The fence apparently serves as a security measure against injury to unauthorized personnel who may frequent the site. Other security measures should be implemented, and a trash rack provided, which does not hamper the capability of the spillway to discharge excess inflow to the reservoir.

3. The discharge culvert outlet for the spillway is caving in and debris partially blocks the outlet. The debris should be removed from the outlet, and the area immediately beyond the outlet and the walls of the culvert should be repaired.

4. The owner should make an evaluation to determine the extent of subsurface mining beneath the dam and its possible effects relative to subsidence.

5. The vegetation on the slopes of the structure should be removed under the direction of a professional engineer knowledgeable in dam design and construction to insure that removal of the vegetation does not adversely affect the stability of the structure.

6. It should be ascertained whether the 6" diameter water line which serves as the feed line for the water supply system is capable of serving as a drainline for the reservoir. If it is determined that the line is capable of serving as a drainline, some means of positive upstream closure of the line should be provided. If the line is determined unsuitable as a drainline, an upstream closure should be provided, or the line should be abandoned, and plugged; and some alternate method devised to drain the reservoir.

7. An investigation should be conducted to determine the type of material which forms the slopes immediately adjacent to the reservoir. The investigation should include the potential for the material to slide into the reservoir, thus reducing the storage potential of the reservoir and the potential for overtopping.

8. A safety inspection program should be implemented with inspections at regular intervals by a qualified personnel.

9. A warning system should be developed to warn downstream residents of large spillway discharges or imminent failure of the dam.

10. A regularly scheduled maintenance program should be prepared and implemented to insure the continued safe operation of the facility.

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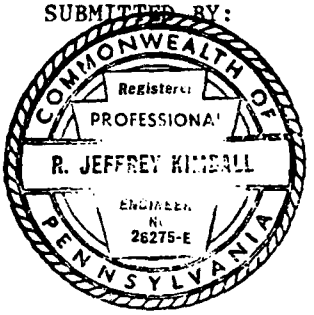

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS AND ARCHITECTS

R Jeffrey Kimball

Date

R. Jeffrey Kimball, P.E.

APPROVED BY:

21 APR 81

Date

James W. Peck

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

Overview of Cold Spring Water Supply Dam

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PHASE I
NATIONAL DAM INSPECTION PROGRAM

COKEBURG WATER SUPPLY DAM
NDI. I.D. NO. PA 1094
DER I.D. NO. 63-30

SECTION 1
PROJECT INFORMATION

1.1 General.

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. The Cokeburg Water Supply Dam is an earthfill dam, 400 feet long and 27 feet high. The crest width is 20 feet. The upstream slope is 1/2H:1V to 1H:1V and grass covered. The downstream slope of the dam is 1H:1V and grass covered. Small trees and brush exist on the upstream and downstream slopes of the structure.

Several abandoned coke ovens are visible on the downstream slope of the structure adjacent to the left abutment contact and above the outlet conduit for the spillway.

The spillway for the Cokeburg Water Supply Dam is located at the left abutment of the structure. The spillway consists of a rectangular concrete drop intake structure. A chainlink fence exists around the inlet to the intake structure. Inflow to the structure is discharged through a rectangular masonry culvert. The outlet for the culvert is located at the downstream toe of the dam.

b. Location. The dam is located on a tributary of the South Branch of Pigeon Creek, within the Cokeburg Borough limits, Washington County, Pennsylvania. The Cokeburg Water Supply Dam can be located on the Ellsworth, U.S.G.S. 7.5 minute quadrangle.

c. Size Classification. The Cokeburg Water Supply Dam is a small size dam (27 feet high, 61 acre-feet).

d. Hazard Classification. The Cokeburg Water Supply Dam is a high hazard dam. Downstream conditions indicate that the loss of more than a few lives and property damage is probable should the structure fail. A small business establishment is located approximately 1,000 feet downstream of the dam.

e. Ownership. The dam is owned by the Borough of Cokeburg. Correspondence should be addressed to:

Mr. Lee Karpoff, Council President
Box 398
Cokeburg, Pennsylvania
412/945-6425

f. Purpose of Dam. The dam is used for water supply.

g. Design and Construction History. The original owner of the Cokeburg Water Supply Dam was the Bethlehem Mines Corporation. The impoundment was originally started about 1902 and was used in conjunction with the mining of the Pittsburgh coal seam. Sometime around 1953 the reservoir was purchased from Bethlehem Mines Corporation by the Cokeburg Borough for use as a water supply reservoir. The impondment is currently used to supply water for Cokeburg, Pennsylvania.

The dam was constructed on top of a bank of abandoned coke ovens. Information in the DER files suggests that the coke ovens were abandoned prior to construction of the dam in 1902. Past inspection reports note seepage through the embankment.

A 1919 inspection report indicates that the dam was originally built with both the upstream and downstream slopes equal to 1.5H:1V. A sketch drawn on that inspection report indicates that coke ovens existed along the downstream toe of the dam and along either downstream abutment. A railroad siding existed along the crest of the dam. Apparently, the railroad siding was utilized for loading the coke ovens as part of the coking process. Other information in the inspection report indicates that two brick core walls, each 9 inches thick with a puddle core between the walls, existed at the time of inspection. It was also noted that a portion of the walls exposed on the crest had fallen down.

It was reported by members of the council, who accompanied the inspection team, that the spillway crest had been raised 10 or 12 years ago to increase the capacity of the reservoir. No information was available regarding who had completed the work or the design associated with the work.

h. Normal Operating Procedures. Normal inflow to the reservoir is discharged through the spillway at the left abutment. The reservoir pool is maintained at the spillway crest elevation, 1072.0. A 6 inch diameter waterline exists near the right abutment of the dam and supplies the normal flow of water to the Borough of Cokeburg. Two manholes exist at the downstream toe of the dam near the right abutment. One of the manholes provides access to the 6 inch waterline.

1.3 Pertinent Data.

a. Drainage Area. 0.53 square mile

b. Discharge at Dam Site (cfs).

Maximum known flood at dam site	Unknown
Drainline capacity at normal pool	None
Spillway capacity at top of dam	750

c. Elevation (U.S.G.S. Datum) (feet). - Field survey based on spillway crest elevation, 1072.0, from U.S.G.S. 7.5 minute quadrangle.

Top of dam - low point	1075.0
Top of dam - design height	Unknown
Maximum pool - design surcharge	Unknown
Normal pool	1072.0
Spillway crest	1072.0
Upstream invert - 6" waterline	Unknown
Downstream invert - 6" waterline (approximate)	1045.0
Maximum tailwater	None
Toe of dam	1047.9

d. Reservoir (feet).

Length of maximum pool (PMF)	1500
Length of normal pool	1200

e. Storage (acre-feet).

Normal pool	37
Top of dam	61

f. Reservoir Surface (acres).

Top of dam	9
Normal pool	7
Spillway crest	7

g. Dam.

Type	Earthfill over abandoned coke oven bank
Length	400 feet
Height	27 feet
Top width	20 feet
Side slopes - upstream	0.5H:1V to 1H:1V
- downstream	1H:1V

Zoning	None
Impervious core	None
Cutoff	Brick (deteriorated)
Grout curtain	None

h. Reservoir Drain.

Type	6" diameter water supply line
Length	Unknown
Closure	Valve at toe
Access	Manhole at downstream toe
Regulating facilities	Valve in manhole

i. Spillway.

Type	Rectangular drop inlet
Length (total crest)	45 feet
Crest elevation	1072.0
Upstream channel	Lake
Downstream channel	Masonry culvert

SECTION 2
ENGINEERING DATA

2.1 Design. Limited information relative to the design of the Cokeburg Water Supply Dam was available in the DER files. Comments made as part of various inspection reports indicate that the dam was constructed by the Bethlehem Mines Corporation to be utilized in the mining of the Pittsburgh coal seam. The Commonwealth of Pennsylvania, Department of Environmental Resources, correspondence file was reviewed for the purposes of this report. Several members of the Cokeburg Borough Council accompanied the inspection team but did not provide any additional information relative to the design of the structure.

2.2 Construction. No information exists relative to the construction of the dam. Remarks contained in various inspection reports indicate that the dam was constructed on top of an abandoned bank of coke ovens.

2.3 Operation. No operating records are maintained.

2.4 Evaluation.

a. Availability. Limited available data was provided by the PennDER, Bureau of Dams and Waterway Management, and through interviews with the owner. Several members of the Cokeburg Borough Council were interviewed to obtain data on the operation and maintenance of the dam.

b. Adequacy. Detailed analysis cannot be made because of the lack of detailed design information. This Phase I Report is based on available data, visual inspection and hydrologic and hydraulic analysis. Sufficient information exists to complete a Phase I Report.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. The onsite inspection of the Cokeburg Water Supply Dam was conducted by personnel of L. Robert Kimball and Associates on November 5, 1980. The inspection consisted of:

1. Visual inspection of the retaining structure, abutments and toe.
2. Examination of the spillway facilities, exposed portion of any outlet works and other appurtenant works.
3. Observations affecting the runoff potential of the drainage basin.
4. Evaluation of the downstream area hazard potential.

b. Dam. The dam appeared to be in poor condition and poorly maintained. From a brief survey conducted during the inspection, it was noted that a low area exists on the embankment crest near the left abutment. The crest width of the dam was measured to be 20 feet. The upstream slope above the water level was measured to be 0.5H:1V to 1H:1V and grass covered. It was also observed that small trees and brush exist on the upstream slope of the dam. The downstream slope of the dam was measured to be 1H:1V and covered with grasses and brush. Large trees were also observed on the downstream slope of the structure. Access to the dam is along an earthen road downstream of the left abutment. The access road continues along the crest of the structure. No major erosion was observed on the crest of the dam. Several coke ovens were observed on the downstream slope near the left abutment and above the outlet culvert for the spillway. It was reported by the owners that coke ovens are present under the entire embankment length. The brick wall, assumed to be used as a cutoff, was partially exposed on the upstream slope. A large part of this wall has failed and fallen into the reservoir. No seepage was observed on the downstream slope or along the toe during the inspection.

c. Appurtenant Structures. The spillway for the reservoir is located near the left abutment through the embankment section. The spillway is a concrete rectangular drop inlet structure, and flows are carried by a masonry culvert through the embankment. The outlet for the culvert is at the downstream toe near the left abutment. A chain link fence exists at the inlet for safety reasons. The inspection team entered the inlet and culvert to inspect the condition of the structure. Seepage was observed exiting from the left interior wall of the culvert. Several concentrated seepage points were observed, and the seepage was estimated at 2 to 3 gallons per minute. The floor of the culvert consists of concrete. The culvert is constructed of rubble masonry with mortar. It was observed that the culvert is in a

deteriorating condition, and the sidewalls at the outlet are caving in. The outlet is partially blocked due to the caving sidewalls. Considerable erosion was observed along the downstream slope of the dam in the area of the culvert outlet. Past erosion has exposed a considerable portion of the outlet culvert.

Two rectangular concrete block structures (manholes) were observed at the toe of the dam near the right abutment contact. It was reported by members of the Council who accompanied the inspection team that one structure supplied access to a gate valve for the water supply line. The second structure was utilized to supply reservoir water to a mine shaft during past mining of the coal seam below the dam. The water was reportedly supplied to the mine through a borehole.

d. Reservoir Area. The watershed is covered mostly with moderate to steep woodlands. The reservoir slopes to the south of the reservoir consist of an old refuse bank. It was reported by members of the Borough Council who accompanied the inspection team that a portion of the slope had slid into the reservoir several years ago. The reservoir surface area is relatively small, and the steep slopes to the south of the reservoir reportedly contain significant amounts of coal refuse. The area may be susceptible to landslides which could potentially affect the storage volume of the reservoir and overtopping of the dam by displacing water if the slopes should slide into the reservoir.

e. Downstream Channel. The downstream channel for the Cokeburg Water Supply Dam consists of a tributary to the South Branch of Pigeon Creek. A small business establishment is located approximately 1,000 feet downstream of the dam.

3.2 Evaluation. In general, the Cokeburg Water Supply Dam and appurtenant structures are in a seriously deteriorated condition. Maintenance of the dam and operating facilities is considered very poor. Major erosion was observed in the area of the outlet culvert for the spillway. The outlet culvert is in a seriously deteriorated condition. Caving in at the outlet of the culvert partially blocks the outlet. Brush and debris exist in the area of the outlet. No seepage was observed on the downstream slope or along the toe of the dam, although the structure has a history of seepage and settlement. No settlement areas were observed during the inspection.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures. The water level is maintained at the spillway crest elevation, 1072. Water is drawn from the reservoir to supply water requirements for the Borough of Cokeburg.

4.2 Maintenance of the Dam. No planned maintenance schedule exists for the dam. The embankment slopes are covered with brush and small trees which hampered the visual inspection.

4.3 Maintenance of Operating Facilities. No planned maintenance program exists for the operating facilities.

4.4 Warning System in Effect. There is no warning system in effect to warn downstream residents of large spillway discharges or imminent failure of the dam.

4.5 Evaluation. The maintenance of the dam and operating facilities is considered poor. The structure is in a seriously deteriorated condition. Trees and brush exist on the embankment slopes, and debris partially blocks the spillway outlet channel. The outlet culvert is caving in and erosion at the outlet is evident.

There is no warning system in effect at the dam. An emergency action plan should be available for every dam in the high and significant hazard category. Such plans should outline actions to be taken by the operator to minimize downstream effects of an emergency and should include an effective warning system.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features.

a. Design Data. No calculations or design data pertaining to the hydrology or hydraulics associated with the dam were available.

b. Experience Data. No rainfall, runoff or reservoir level data were available. The spillway reportedly has functioned adequately in the past.

c. Visual Observations. The spillway appeared to be in poor condition. A chain link fence surrounds the crest of the drop inlet structure. The fence has the potential to block inflow to the drop inlet, since debris could collect on the fence. The spillway discharge culvert is caving in at the outlet and the outlet is partially blocked.

The low spot on the top of dam (1075.0) was noted as existing near the left abutment of the structure.

d. Overtopping Potential. Overtopping potential was investigated through the development of the probable maximum flood (PMF) for the watershed and the subsequent routing of the PMF and fractions of the PMF through the reservoir and spillway.

The Corps of Engineers, Baltimore District, has directed that the HEC-1 Dam Safety Version systemized computer program be utilized. The program was prepared by the Hydrologic Engineering Center (HEC), U.S. Army Corps of Engineers, Davis, California, July, 1978. The major methodologies or key input data for this program are discussed briefly in Appendix D.

5.2 Evaluation Assumptions. To enable completion of the hydraulic and hydrologic analysis for this structure, it was necessary to make the following assumptions.

1. The pool level in the reservoir prior to the storm was assumed to be at the spillway crest elevation, 1072.0.

2. The top of dam was considered the low spot at elevation 1075.0.

3. The chain link fence which surrounds the intake to the drop inlet was ignored during the analysis. Debris could collect on the fence and block inflow to the drop inlet.

4. The embankment soils appeared to be highly susceptible to erosion; and based on the evaluating engineers judgement, a pool elevation of 1076.0 was sufficient to cause failure by overtopping.

5.3 Summary of Overtopping Analysis. Complete summary sheets for the computer output are presented in Appendix D.

Peak inflow (PMF)	2620 cfs
Spillway capacity	750 cfs

a. Spillway Adequacy Rating. The Spillway Design Flood is based on the hazard and size classification of the dam. The recommended Spillway Design Flood (SDF) for a small size dam is in the range of 1/2 PMF to PMF. The Spillway Design Flood for this dam was selected to be the PMF based on the downstream potential for loss of life. Based on the following definition provided by the Corps of Engineers, the spillway is rated as seriously inadequate as a result of our hydrologic analysis. The spillway and reservoir are capable of controlling less than 30% of the PMF without overtopping the embankment.

> Seriously inadequate - All high hazard dams not capable of passing 50% of the Spillway Design Flood (PMF) and where there is a significant increase in the downstream hazard potential due to dam failure from that which exists prior to the failure.

5.4 Summary of Dam Breach Analysis. As the subject dam cannot satisfactorily pass 50% of the PMF, it was necessary to perform a dam breach analysis and downstream routing of the flood wave. This analysis determines the degree of increased flooding due to dam failure. The results of the dam breach analysis indicate that downstream flooding is significantly increased. Since flooding downstream is significantly increased due to dam failure, the spillway is considered seriously inadequate. The Cokeburg Water Supply Dam is classified as an unsafe, non-emergency structure. Input data for the HEC-1 dam breach program appear in Appendix D.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. The inspection of the Cokeburg Water Supply Dam revealed several deficiencies which were considered as having a significant affect on the stability of the structure. Coke ovens were observed on the downstream slope near the left abutment of the structure. The coke ovens were open. The openings to the coke ovens were not sealed, and the potential exists for the fill material within the ovens to erode out of the openings. The existence of the coke ovens is verified by a 1919 Water Supply Commission inspection report. The potential exists for settlement of the material in the ovens, and the structures could collapse and cause settlement of the embankment. Information in the DER files suggest that some settlement has occurred near the right abutment of the structure. It is unclear as to the date associated with the settlement.

The outlet for the spillway discharge culvert is collapsing and debris partially blocks the outlet. The condition of the culvert outlet appears to be due to erosion and settlement in the area of the outlet.

No major erosion or settlement was observed on the embankment crest during the inspection. No seepage was observed on the downstream slope or along the toe of the embankment. Seepage estimated at 2 to 3 GPM was observed on the left interior wall of the culvert near the inlet. The upstream and downstream slopes contain considerable brush and trees. The existence of the trees on the embankment slopes increases the potential for the development of erosion cavities and slides.

b. Design and Construction Data. No design or construction data are available. Limited information is available in the DER files relative to the general characteristics of the site during various periods leading up to the present day facility. No known stability analysis exists for this dam.

c. Operating Records. No operating records are maintained.

d. Post Construction Changes. No post construction changes are known to have occurred at the dam in the recent past.

e. Seismic Stability. The dam is located in seismic zone 1. No seismic stability analyses are known to have been performed. Normally, it can be considered that if a dam in this zone is stable under static loading conditions, it can be assumed safe for any expected earthquake loading. The conditions as previously discussed in Section 6.1a indicate that the static stability of the structure is questionable with regards to minimum factors of safety associated with current criteria.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety. The dam appears to be in poor condition and poorly maintained. The stability of the structure is questionable due to the existence of coke ovens in the downstream slope of the embankment and failure of the brick wall. The possibility also exists that erosion cavities exist within the embankment and could lead to potential piping of the structure or settlement of the embankment which would increase the potential for overtopping failure. Considerable erosion and/or settlement has occurred near the outlet of the spillway discharge culvert. The interior walls of the culvert at the outlet are caving in and debris partially blocks the outlet. Portions of the reservoir slopes may contain coal refuse which could lead to potential landslides affecting the storage and volume of the reservoir. During periods of heavy precipitation, a potential landslide could occur increasing the possibility for overtopping of the structure.

The structure has a past history of seepage, although no seepage was observed on the downstream slope or along the toe area of the structure during the inspection. Seepage estimated at 2 to 3 GPM was observed on the left interior wall of the culvert, at the inlet.

The visual observations, review of available data, hydraulic and hydrologic calculations and the past operational performance of the structure indicate that the Cokeburg Water Supply Dam's spillway is seriously inadequate. The spillway is capable of controlling 30% of the PMF without overtopping the embankment. No known stability analysis have been performed for this structure. The dam is an unsafe, non-emergency structure.

b. Adequacy of Information. Sufficient information is available to complete a Phase I report.

c. Urgency. The recommendations suggested below should be implemented immediately.

d. Necessity for Further Investigation. In order to accomplish some of the recommendations/remedial measures outlined below, further investigations will be required.

7.2 Recommendations/Remedial Measures.

1. A detailed stability and seepage analysis should be conducted by a registered professional engineer knowledgeable in dam design and construction and should be conducted in conjunction with a detailed hydraulic and hydrologic analysis of the structure to increase the spillway capacity and to document the stability of the structure.

2. The fence which surrounds the inlet for the spillway should be removed. The location and type of fence is such that it may reduce the spillway capacity by collecting debris. The fence apparently serves as a security measure against injury to unauthorized personnel who may frequent the site. Other security measures should be implemented, and a trash rack provided, which does not hamper the capability of the spillway to discharge excess inflow to the reservoir.

3. The discharge culvert outlet for the spillway is caving in and debris partially blocks the outlet. The debris should be removed from the outlet, and the area immediately beyond the outlet and the walls of the culvert should be repaired.

4. The owner should make an evaluation to determine the extent of subsurface mining beneath the dam and its possible effects relative to subsidence.

5. The vegetation on the slopes of the structure should be removed under the direction of a professional engineer knowledgeable in dam design and construction to insure that removal of the vegetation does not adversely affect the stability of the structure.

6. It should be ascertained whether the 6" diameter water line which serves as the feed line for the water supply system is capable of serving as a drainline for the reservoir. If it is determined that the line is capable of serving as a drainline, some means of positive upstream closure of the line should be provided. If the line is determined unsuitable as a drainline, an upstream closure should be provided, or the line should be abandoned, and plugged; and some alternate method devised to drain the reservoir.

7. An investigation should be conducted to determine the type of material which forms the slopes immediately adjacent to the reservoir. The investigation should include the potential for the material to slide into the reservoir, thus reducing the storage potential of the reservoir and the potential for overtopping.

8. A safety inspection program should be implemented with inspections at regular intervals by a qualified personnel.

9. A warning system should be developed to warn downstream residents of large spillway discharges or imminent failure of the dam.

10. A regularly scheduled maintenance program should be prepared and implemented to insure the continued safe operation of the facility.

APPENDIX A
CHECKLIST, VISUAL INSPECTION, PHASE I

CHECK LIST
VISUAL INSPECTION
PHASE I

NAME OF DAM Cokeburg Water Supply Dam COUNTY Washington STATE Pennsylvania ID# 1094

TYPE OF DAM Earthfill HAZARD CATEGORY High

DATE(s) INSPECTION November 5, 1980 WEATHER Clear and cool TEMPERATURE 35°

POOL ELEVATION AT TIME OF INSPECTION 1071.2 M.S.L. TAILWATER AT TIME OF INSPECTION None M.S.L.

INSPECTION PERSONNEL:

R. Jeffrey Kimball, P.E. - L. Robert Kimball and Associates

James T. Hockensmith - L. Robert Kimball and Associates

O.T. McConnell - L. Robert Kimball and Associates

Lee Karpoff, Council President - Cokeburg Borough Council

Mr. Michael Megles - Cokeburg Borough Councilman

Mr. Charles Pscolka - Cokeburg Borough Councilman

O.T. McConnell
RECORDER

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None noted.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	Considerable erosion and/or settlement at outlet for spillway culvert.	The outlet is caving in and should be repaired.
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Considerable erosion at the toe of the downstream slope adjacent to the left abutment in the area of the spillway outlet culvert.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	No signs suggesting settlement or movement of the embankment noted during the inspection.	
RIPRAP FAILURES	No riprap on the upstream slope. Minor erosion observed.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
VEGETATION	Considerable vegetation on the upstream and downstream slopes.	Vegetation should be removed.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No deficiencies observed.	
ANY NOTICEABLE SEEPAGE	Minor seepage observed on the left interior wall of the spillway discharge culvert at the inlet. Seepage flow estimated at 2 to 3 gallons per minute.	
STAFF GAUGE AND RECORDER	None.	
DRAINS	None.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	Not applicable.	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Not applicable.	
DRAINS	Not applicable.	
WATER PASSAGES	Not applicable.	
FOUNDATION	Not applicable.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	Not applicable.	
STRUCTURAL CRACKING	Not applicable.	
VERTICAL AND HORIZONTAL ALIGNMENT	Not applicable.	
MONOLITH JOINTS	Not applicable.	
CONSTRUCTION JOINTS	Not applicable.	
STAFF GAUGE OR RECORDER	Not applicable.	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	The outlet conduit is in a deteriorating condition and the outlet is caving in. Debris partially blocks the outlet.	The outlet culvert should be repaired and debris removed at the outlet.
INTAKE STRUCTURE	Appeared to be in good condition except for a fence which surrounds the crest.	The fence should be removed since it hampers the capability of the spillway to discharge excess inflow to the reservoir.
OUTLET STRUCTURE	Outlet structure constructed of masonry rubble with mortar. Outlet for the culvert is caving in.	
OUTLET CHANNEL	Natural stream at outlet, debris exists in the channel.	The debris should be removed from the outlet channel.
EMERGENCY GATE	Gate valve on 6" water supply feed line. The control valve is located in a manhole at the downstream toe of the dam.	The valve was not operated during the inspection.

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Semi-broad crest. Concrete appeared to be in good condition. A chain link fence surrounds the intake inlet.	The fence should be removed.
APPROACH CHANNEL	Lake, restricted by chain link fence.	
DISCHARGE CHANNEL	Masonry rubble culvert with concrete channel bottom to natural stream.	
BRIDGE AND PIERS	None.	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	Not applicable.	
APPROACH CHANNEL	Not applicable.	
DISCHARGE CHANNEL	Not applicable.	
BRIDGE AND PIERS	Not applicable.	
GATES AND OPERATION EQUIPMENT	Not applicable.	

DOWNSTREAM CHANNEL

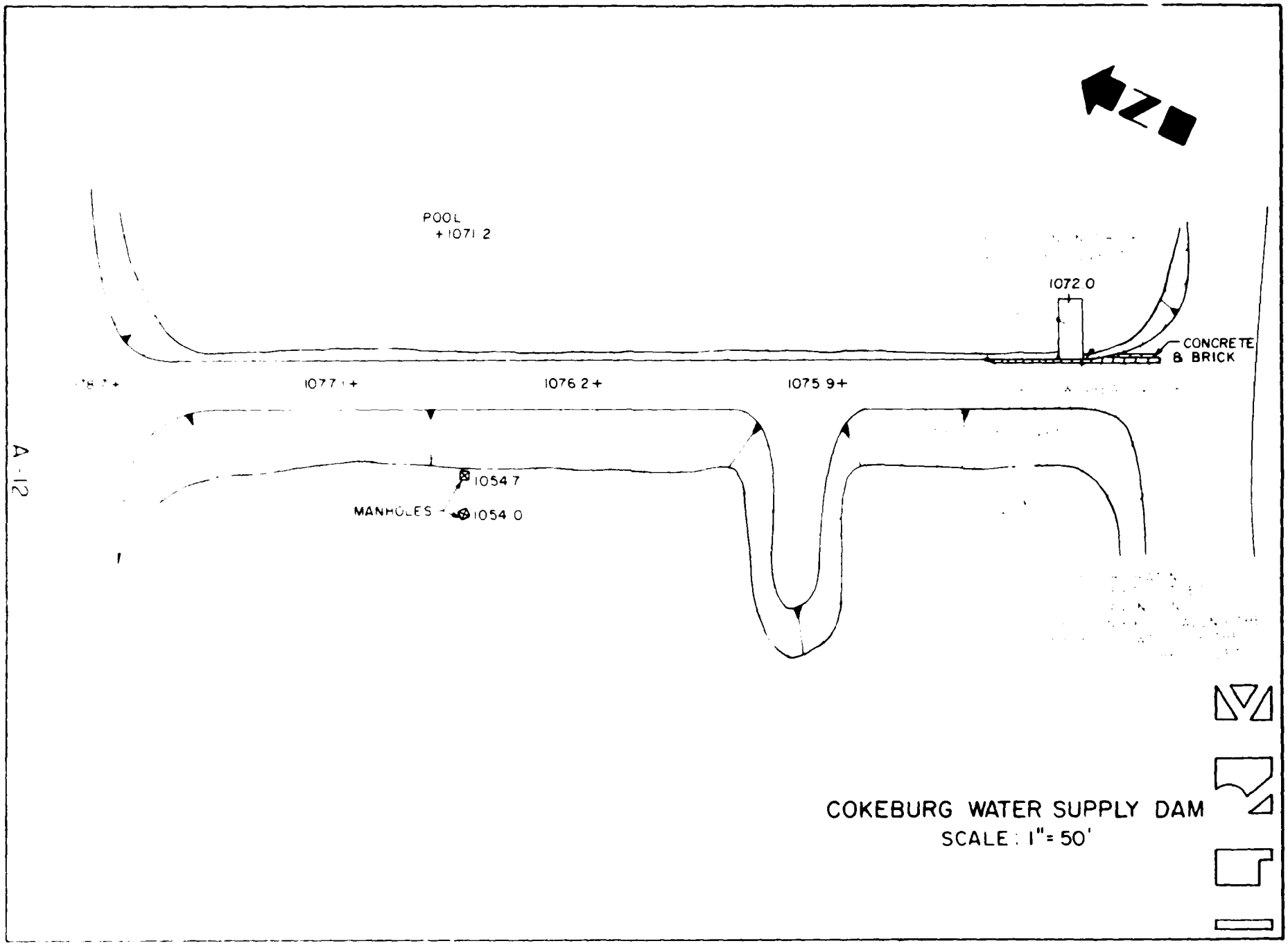
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The downstream channel for the Cokeburg Water Supply Dam consists of a natural stream to a tributary of the South Branch of Pigeon Creek. The channel below the spillway outlet culvert is partially blocked.	The debris blocking the channel should be removed.
SLOPES	Channel slopes appear to be stable.	
APPROXIMATE NO. OF HOMES AND POPULATION	One small business is located approximately 1,000 feet downstream of the dam. The population would consist of employees at the business. Population estimated at 6 to 8 people.	

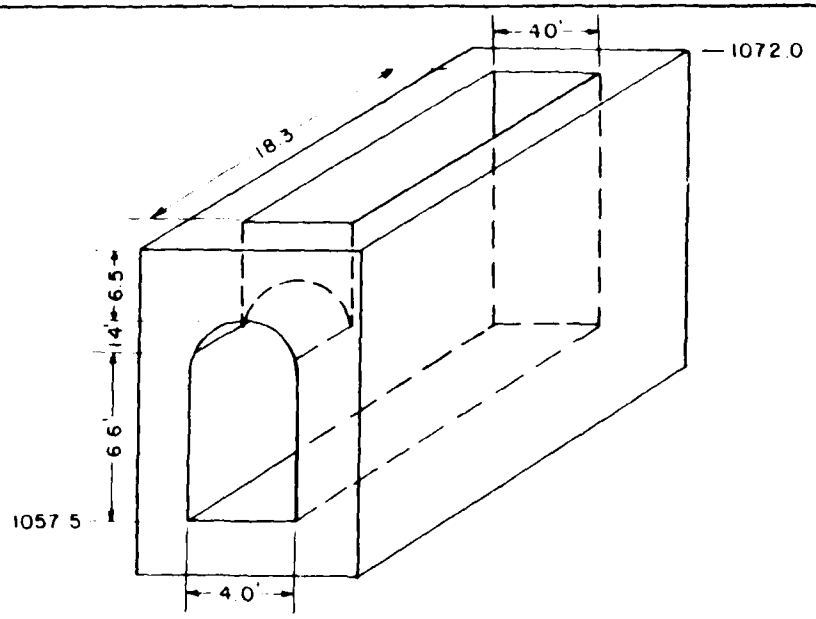
RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Moderate to steep. Slopes may be formed by mine refuse. Stability of the slopes is questionable.	Slopes should be investigated and stability analyzed if necessary.
SEDIMENTATION	Unknown.	

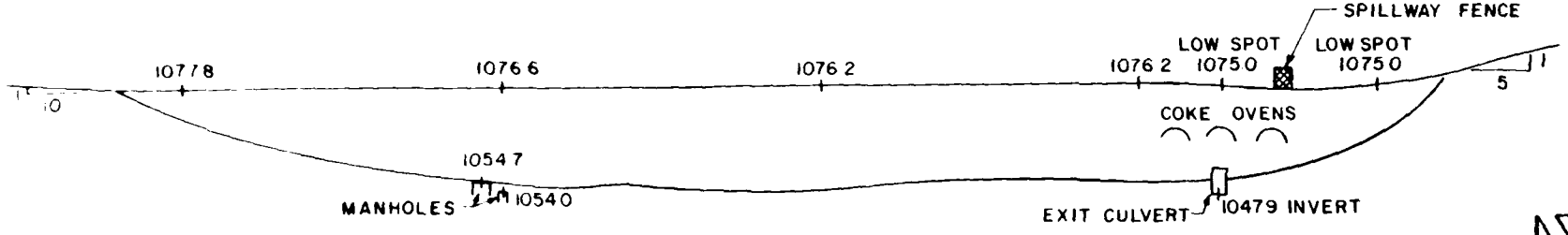
INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None.	
OBSERVATION WELLS	None.	
WEIRS	None.	
PIEZOMETERS	None.	
OTHER	None.	


POOL
+1071.2
1072.0
CONCRETE
& BRICK
1077.1+
1076.2+
1075.9+
1054.7
MANHOLES
1054.0
COKEBURG WATER SUPPLY DAM
SCALE: 1"= 50'



SPILLWAY INTAKE AND CULVERT ENTRANCE
LOOKING UPSTREAM
SCALE AS SHOWN



PROFILE
LOOKING UPSTREAM
SCALE: 1"=50'

COKEBURG WATER SUPPLY DAM

APPENDIX B
CHECKLIST, ENGINEERING DATA, DESIGN, CONSTRUCTION, OPERATION, PHASE I

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Cokeburg Water Supply Dam

ID# PA 1094

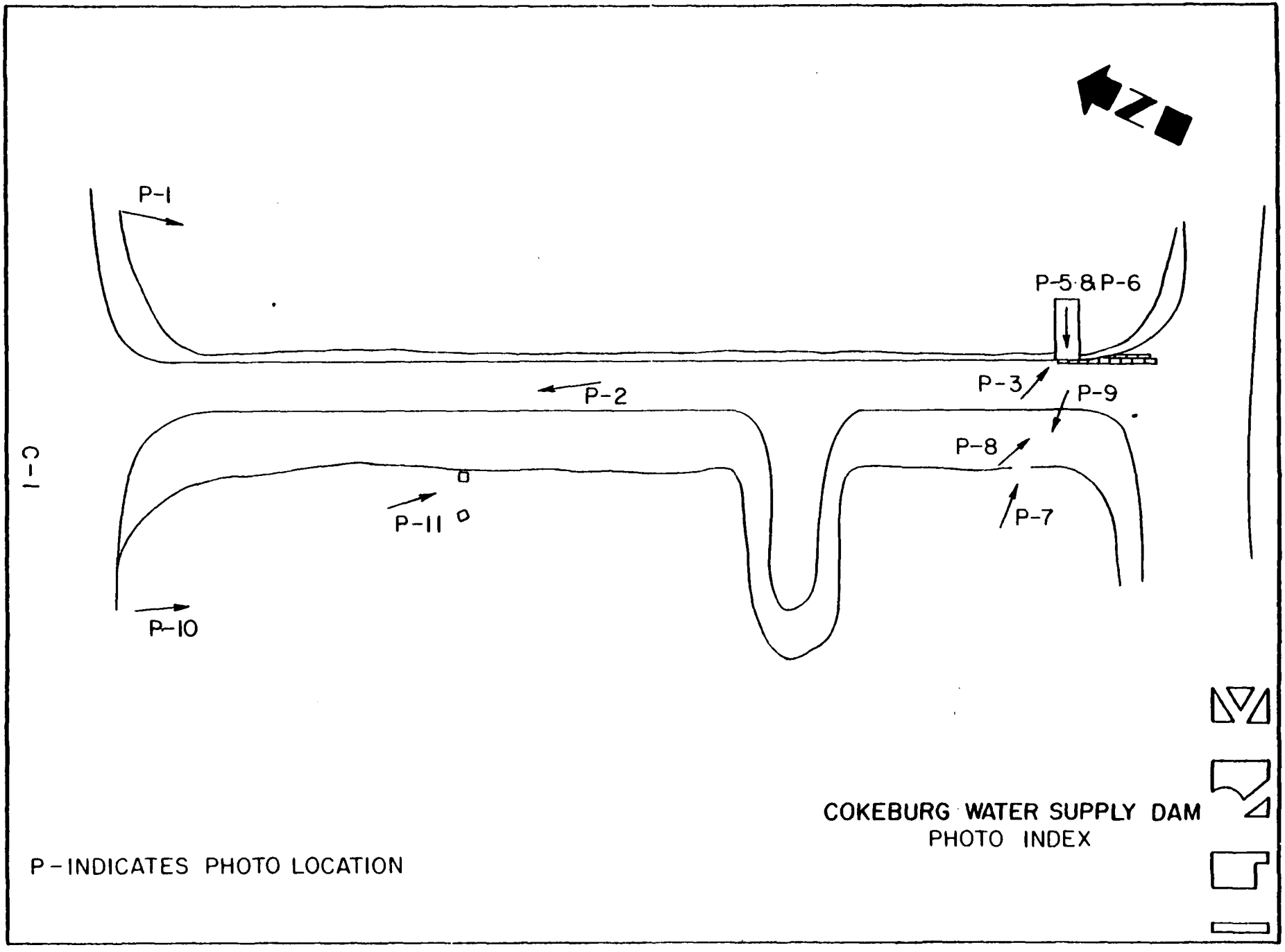
ITEM	REMARKS
AS-BUILT DRAWINGS	None available.
REGIONAL VICINITY MAP	U.S.G.S. 7.5 minute Ellsworth quadrangle.
CONSTRUCTION HISTORY	Limited information available in DER files.
TYPICAL SECTIONS OF DAM	Approximate sketch in DER files. See Appendix D.
OUTLETS - PLAN	None.
- DETAILS	None.
- CONSTRAINTS	None.
- DISCHARGE RATINGS	None.
RAINFALL/RESERVOIR RECORDS	None.

ITEM	REMARKS
DESIGN REPORTS	None.
GEOLOGY REPORTS	None.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None known to exist.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Unknown.
POST-CONSTRUCTION SURVEYS OF DAM	None known to have occurred.
BORROW SOURCES	Unknown.

ITEM	REMARKS
MONITORING SYSTEMS	None.
MODIFICATIONS	None known to have occurred in the recent past.
HIGH POOL RECORDS	None.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None known to have existed.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Information in the DER files suggest that past settlement has occurred at the structure. No major failure to the structure reported due to the settlement.
MAINTENANCE OPERATION RECORDS	None.

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	See Appendix D.
OPERATING EQUIPMENT PLANS & DETAILS	None.

APPENDIX C
PHOTOGRAPHS



C-1

COKEBURG WATER SUPPLY DAM
PHOTO INDEX

P - INDICATES PHOTO LOCATION

COKEBURG WATER SUPPLY DAM
PA 1094

Sheet 1

Front

(1) Upper left - View of upstream slope and left abutment.
(2) Upper right - View of upstream slope, embankment crest and right abutment.
(3) Lower left - View of the spillway intake structure.
(4) Lower right - View of seepage along the culvert wall directly inside the entrance to the culvert.

Back

(5) Upper left - View of the approach to the spillway culvert.
(6) Upper right - View of drop inlet section of spillway.
(7) Lower left - View of the outlet for the discharge culvert. Note the deterioration and collapse of the walls near the outlet.
(8) Lower right - Partial view of the downstream slope directly above the spillway discharge culvert. Note the deterioration of the coke oven structure and the obvious void directly inside the oven entrance.

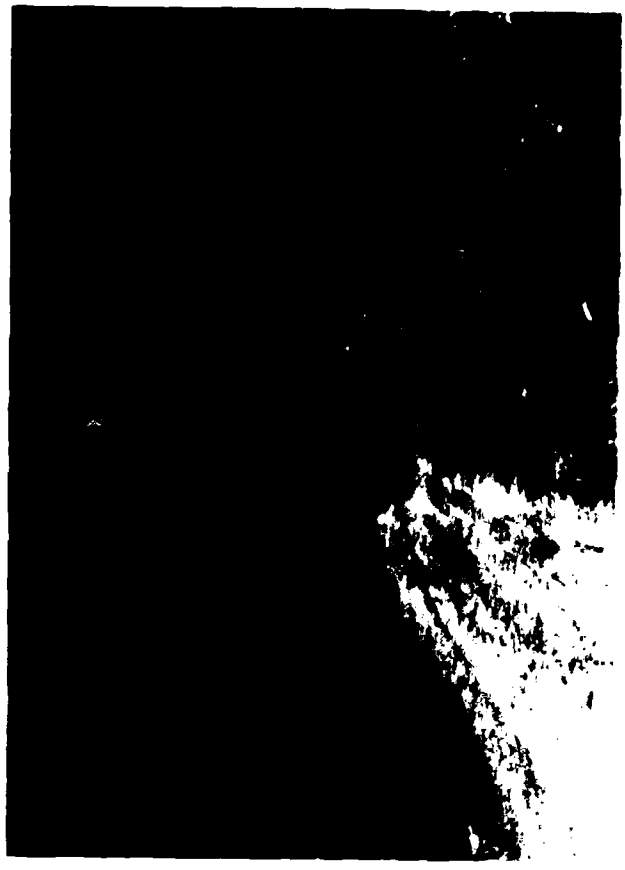
Sheet 2

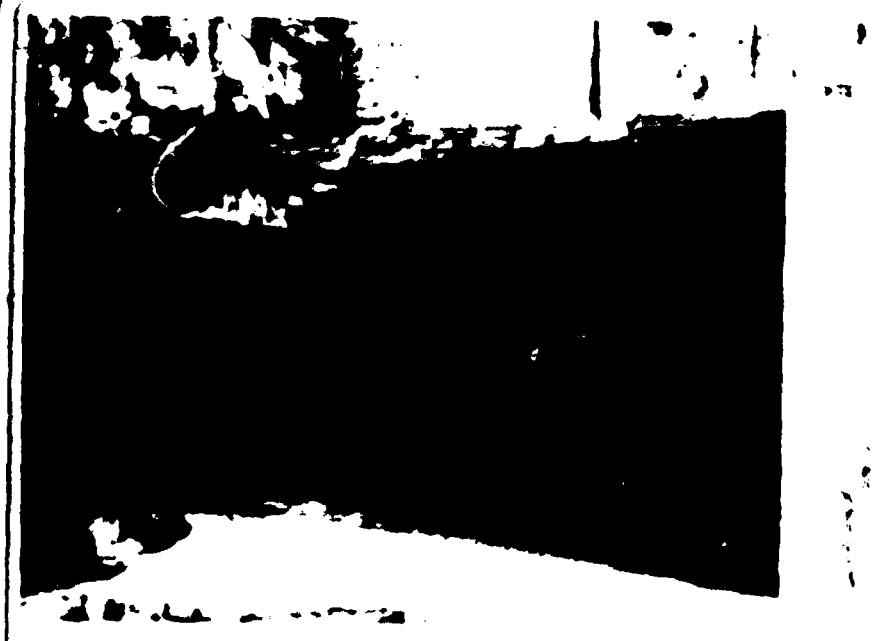
Front

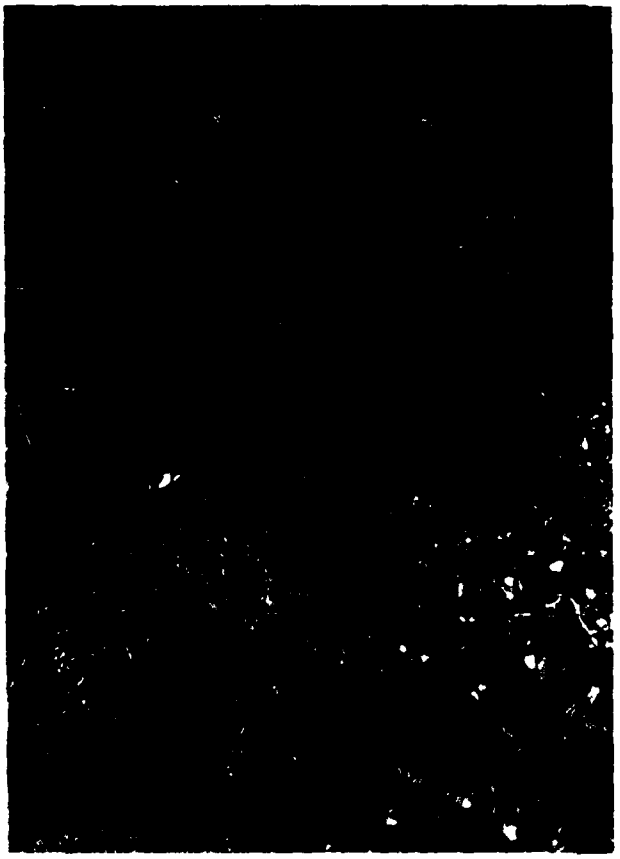
(9) Upper left - View along the top of the outlet culvert. View from the crest looking down onto the top of the culvert. Note the erosion along the edges of the culvert.
(10) Upper right - Downstream slope. View towards the left abutment.
(11) Lower left - View of control valve which regulates flow to a borehole to a mine shaft located some distance below the embankment.
(12) Lower right - Downstream exposure.

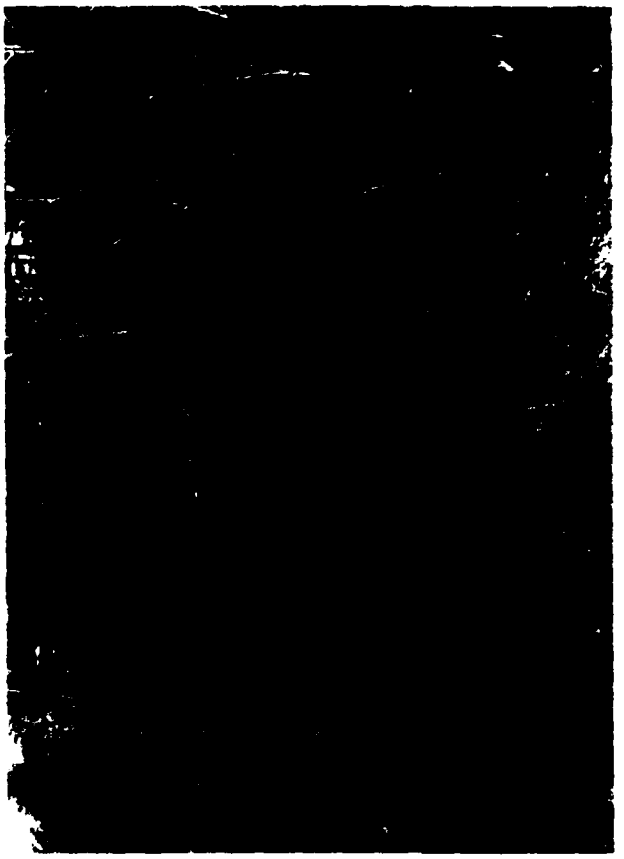
TOP OF PAGE

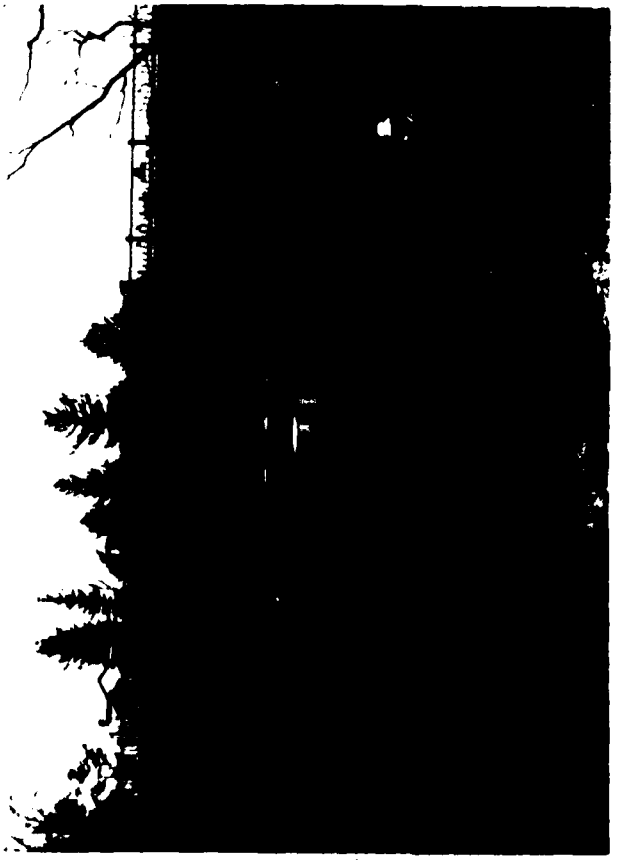
1,5,9	2,6,10
3,7,11	4,8,12











APPENDIX D
HYDROLOGY AND HYDRAULICS

APPENDIX D
HYDROLOGY AND HYDRAULICS

Methodology. The dam overtopping and breach analyses were accomplished using the systemized computer program HEC-1 (Dam Safety Investigation), September, 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. A brief description of the methodology used in the analysis is presented below.

1. Precipitation. The Probable Maximum Precipitation (PMP) is derived and determined from regional charts prepared from past rainfall records including "Hydrometeorological Report No. 33" prepared by the U.S. Weather Bureau.

The index rainfall may be reduced from 10% to 20% depending on watershed size by utilization of what is termed the HOP Brook adjustment factor. Distribution of the total rainfall is made by the computer program using distribution methods developed by the Corps.

2. Inflow Hydrograph. The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for reservoir routing.

The unit hydrograph is developed using the Snyder method. This method requires calculation of several key parameters. The following list gives these parameters their definition and how they were obtained for these analysis.

Parameter	Definition	Where Obtained
Ct	Coefficient representing variations of watershed	From Corps of Engineers*
L	Length of main stream channel miles	From U.S.G.S. 7.5 minute topgraphic
Lca	Length on main stream to centroid of watershed	From U.S.G.S. 7.5 minute topographic
Cp	Peaking coefficient	From Corps of Engineers*
A	Watershed size	From U.S.G.S. 7.5 minute topographic

*Developed by the Corps of Engineers on a regional basis for Pennsylvania.

3. Routing. Reservoir routing is accomplished by using Modified Plus routing techniques where the flood hydrograph is routed through reservoir storage. Hydraulic capacities of the outlet works, spillways and the crest of the dam are used as outlet controls in the routing.

The hydraulic capacity of the outlet works can either be calculated and input, or sufficient dimensions input, and the program will calculate in elevation discharge relationship.

Storage in the pool area is defined by an area - elevation relationship from which the computer calculates storage. Surface areas are either planimetered from available mapping or U.S.G.S. 7.5 minute series topographic maps or taken from reasonably accurate design data.

4. Dam Overtopping. Using given percentages of the PMF, the computer program will calculate the percentage of the PMF, which can be controlled by the reservoir and spillway without the dam overtopping.

5. Dam Breach and Downstream Routing. The computer program is equipped to determine the increase in downstream flooding due to failure of the dam caused by overtopping. This is accomplished by routing both the pre-failure peak flow and the peak flow through the breach (calculated by the computer with given input assumptions) at a given point in time and determining the water depth in the downstream channel. Channel cross-sections taken from U.S.G.S. 7.5 minute topographic maps were used in the downstream flood wave routing. Pre and post failure water depths are calculated at locations where cross-sections are input.

HYDROLOGY [illegible]

NAME OF DAM: Cokeburg Water [illegible]

PROBABLE MAXIMUM PRECIPITATION (PMP) - [illegible]

STATION

Station Description [illegible]

Drainage Area
Square miles .

Cumulative Drainage Area
Square miles .

Adjustment of PMP for
Drainage Area [illegible]
6 hours .
12 hours .
24 hours .
48 hours .
72 hours N/A

Snyder Hydrograph
Parameters
Ct (3) .
Cp (3) .
Ct (3) .
L (miles) (4) .
Lca (miles) (4) .
tp = Ct(LxLca) .3 hrs. .

Spillway Data
Crest Length (ft) [illegible]
Freeboard (ft) 3.
Discharge Coefficient N/A
Exponent N/A

(1) Hydrometeorological Report 33 (Figure 1), U.S. Weather Bureau and U.S. Army Corp of Engineers, 1956.
(2) Hydrological zone defined by Corps of Engineers, Baltimore District, for determining Snyder's coefficients [illegible]
(3) Snyder's Coefficients.
(4) L=Length of longest water course from outlet to [illegible]
L_{ca}=Length of water course from outlet to point opposite the centroid of drainage area.

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: .51 sq.mi.

ELEVATION TOP NORMAL POOL STORAGE CAPACITY): 1072.0 [37 ac-ft]

ELEVATION TOP FLOOD CONTROL POOL STORAGE CAPACITY): 1075.0 [61 ac-ft]

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: [illegible] low spot

SPILLWAY CREST:

a. Elevation 1072.0
b. Type Weir [inlet
c. Width .5 feet
d. Length .5 feet [total]
e. Location spillway Left abutment
f. Number and Type Gates None

OUTLET WORKS:

a. Type 8" diameter water supply feed line
b. Location Left abutment near right abutment
c. Entrance inverts [illegible]
d. Exit inverts [illegible]
e. Emergency drawdown facilities 8" diameter water supply feed line

HYDROMETEOROLOGICAL GAGES:

a. Type [illegible]
b. Location [illegible]
c. Records [illegible]

MAXIMUM NON-DAMAGING DISCHARGE [illegible]

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EBENSBURG PENNSYLVANIA

NAME COLE-CE DAM
NUMBER PA-374
SHEET NO. ___ OF 4
BY ___ DATE 3 3

LOSS RATE AND BASE FLOW PARAMETERS

STRTL = N/A
CNSTL = 0.05 IN-2
STRTQ = 1.5 CFS M-2
QRCSN = 0.05 (5% OF PEAK FLOW)
RTIOR = 2.0

AS RECOMMENDED BY THE BALTIMORE DIST OF CORPS OF ENGINEERS.

ELEVATION-AREA-CAPACITY RELATIONSHIPS

FROM U.S.G.S. 7.5 MIN. QUAD., DEC FILES AND FIELD INSPECTION DATA.

SPILLWAY CREST ELEVATION (U.S.G.S.) = 1072.0
SURFACE AREA AT NORMAL POOL = 7.4 ACRES
TOTAL DRAINAGE DEC FILE (APPROX.) = 36.5 SQ. MI.

FROM THE CORPS METHOD FOR DEVELOPING FLOOD HYDROGRAPH PACKAGE (HEC-1) DAM SAFETY VERSION (USERS MANUAL).

$K = 3 V/A$
$= 3(37) / 7.4$
$= 15.0$

ELEVATION WHERE AREA EQUALS ZERO;

$1072.0 - 15.0 = 1057.0$

FROM U.S.G.S.

AT ELEV. 1050, AREA = 12 ACRES
AT ELEV. 1100, AREA = 23 ACRES

TOP OF DAM (ON SPOT ELEVATION) = 1075.0

NAME

NUMBER PA-1034

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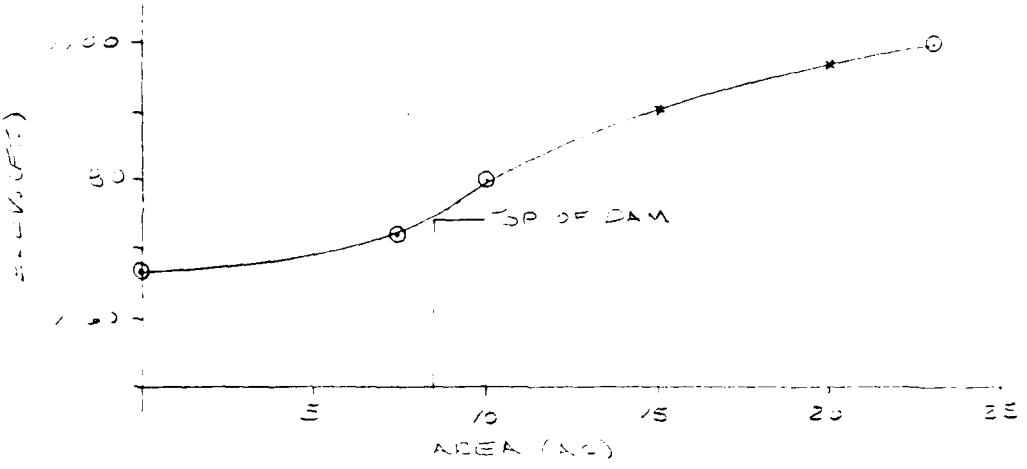
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

SHEET NO. 2 OF 4

BY CTM DATE 3 81



AREA (AC)	0	7.4	9.5	15	20	23
ELEV (FT)	057	072	1075	080	087	00

DISCHARGE RATING

WEIR FLOW :

$Q = CLH^{3/2}$ USE $C = 3.2$ (FENCE NOT CONSIDERED)
$L = 45'$

CULVERT FULL FLOW, ENTRANCE CONTROLS:
CONSIDERED AS CONDUIT WITH DROP INLET.

$Q = A\sqrt{\frac{2gh}{1 + \Sigma \text{ LOSSES}}}$ LET $C = \frac{1}{\sqrt{1 + \Sigma \text{ LOSSES}}} = 0.$

$\therefore Q = CA\sqrt{2gh}$ WHERE h = DIFF ELEV - CULVERT EXIT INVERT

OVERTOPPING :

$Q = CLH^{3/2}$ USE $C = 3.0$ (BROAD CREST)
L VARIES WITH -

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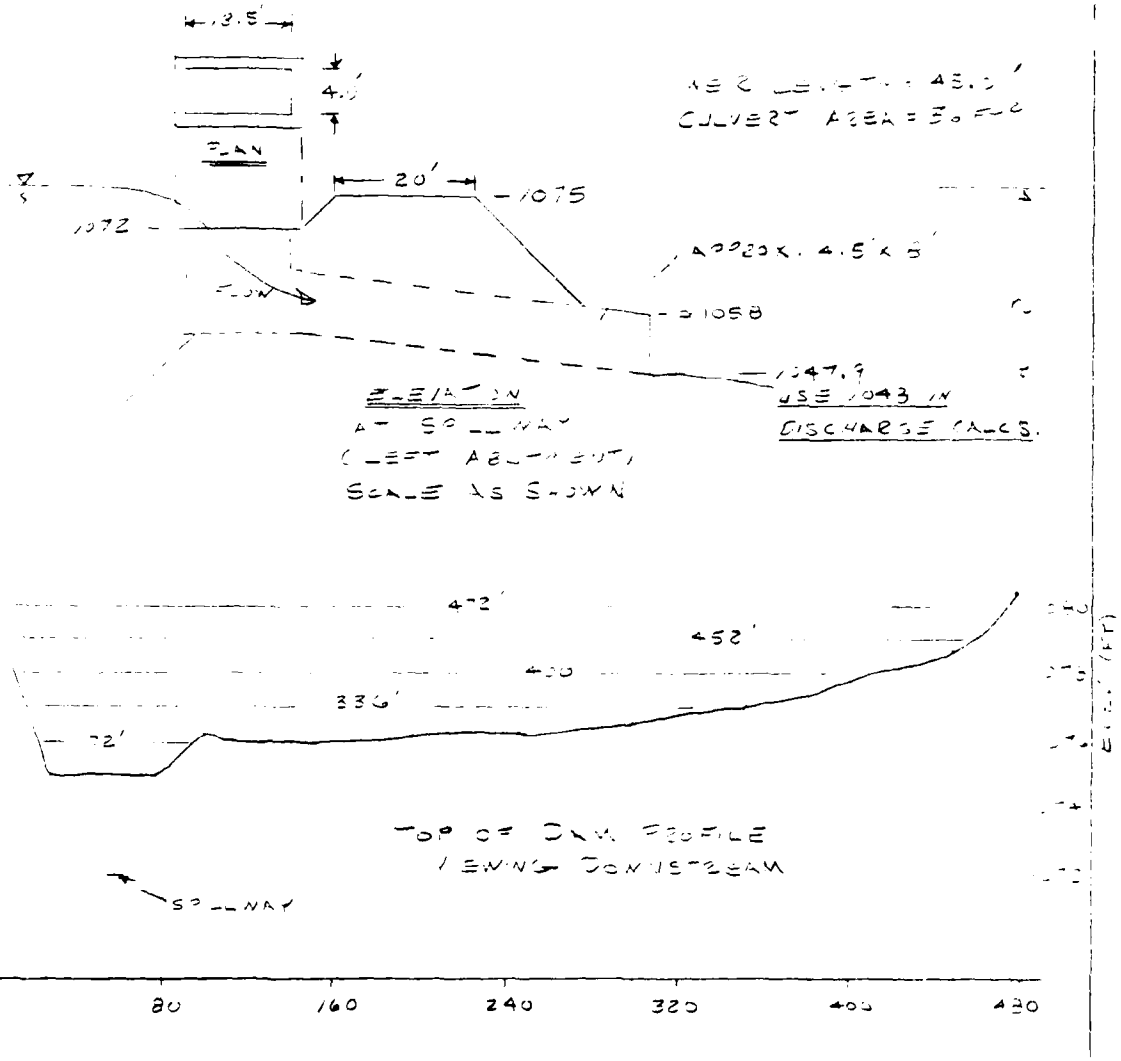
EBENSBURG PENNSYLVANIA

NAME
NUMBER PA-1034
SHEET NO. 3 OF 4
BY OTM DATE 3-31



NOTE: OVERTOPPING WILL FIRST OCCUR AT THE LEFT ABUTMENT. THE AREA OF THE SPILLWAY.

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EBENSBURG PENNSYLVANIA

NAME
NUMBER FA-074
SHEET NO. 4 OF 4
BY CTM DATE 3/81

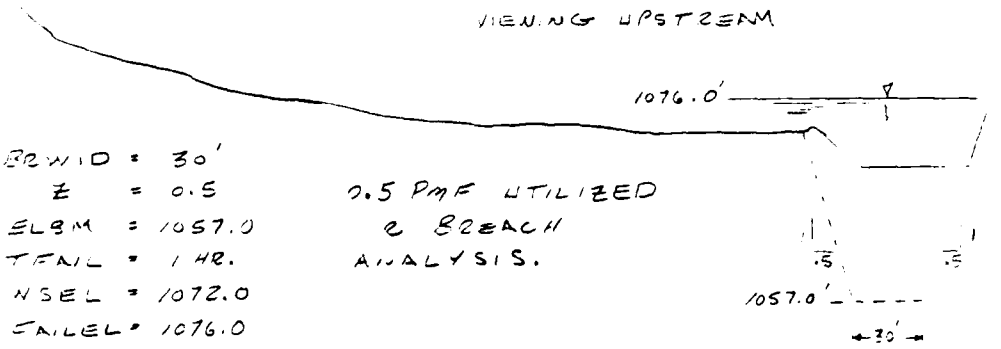
CATCH CURVE INCLUDES OVERTOPPING.

ELEV. (FT.)	NO FLOW		FULL FLOW IN CULVERT		OVERTOPPING			DISCHARGE *Q (cfs)
	h (FT)	Q (cfs)	h (FT.)	Q (cfs)	h (FT)	L (FT)	Q (cfs)	
072	0	—						0
073	1	145						145
074	2	405						405
075	3	750	~~27~~	~~700~~				750
076	~~4~~	~~1152~~	28	920	1	72	2:5	1,155
076.5			28.5	925	1.5	280	1545	2,470
077			29	935	2	336	2,850	3,785
078			30	950	3	400	6,235	7,185
079			31	965	4	452	10,850	11,815
080			32	980	5	472	15,830	16,810

BREACH ANALYSIS

SEE FIG. PAGE 3 OF 4

DRAWING NOT TO SCALE.
VIEWING UPSTREAM



BRWID = 30'
Z = 0.5
ELBM = 1057.0
TFAIL = 1 HR.
NSEL = 1072.0
FAILEL = 1076.0

0.5 PMF UTILIZED
@ BREACH
ANALYSIS.

CREACH CROSS-SECTIONS FROM U.S.G.S. 7.5 MIN. QUAD. SEE PAGE E-1. OVERBANK MANNINGS' n = 0.06 (ASSUMED), CHANNEL MANNINGS' n = 0.05 (ASSUMED).

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
  LAST MODIFICATION  01 APR 80
**********
    1                A1       ANALYSIS OF DAM OVERTOPPING USING RATIOS OF THE PMF
    2                A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF COKEBURG RESERVOIR AND DAM
    3                A3       RATIOS OF THE PMF ROUTED THROUGH THE RESERVOIR (DA=10943
    4                B    288         0        10         0         0         0         0         0         0         0
    5                B1     5
    6                J      1         4         1
    7                J1   .05        .1        .5         1
    8                K      0         1                                                1
    9                K1       INFLOW
   10                M      1         1     0.53                                       1
   11                P             24.25       102       120       130       140
   12                T                                                          1.0      0.05
   13                W   0.64      0.50
   14                X   -1.5      -.05       2.0
   15                K      1         2                                                1
   16                K1       ROUTE THROUGH COKEBURG
   17                Y                                    1         1
   18                Y1     1                                                      -1072        -1
   19                Y4  1072      1073      1074      1075      1076    1076.5      1077      1078      1079      1080
   20                Y5     0       145       405       750      1135      2470      3785      7185     11815     16810
   21                $A     0       7.4       8.5        15        20        23
   22                $I  1057      1072      1075      1090      1097      1100
   23                $$  1072
   24                $D  1075
   25                K     99
```

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********

RUN  DATE= 81/03/16.
     TIME= 05.33.20.
```

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF THE PMF
HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF COREBORG RESERVOIR AND DAM
RATIOS OF THE PMF ROUTED THROUGH THE RESERVOIR (PA-1094)

JOB SPECIFICATION

IN	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	10	0	0	0	0	0	0	0

	JOPER	NWT	LROPT	TRACE
	5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 4 LRTIO= 1

RTIOS= .05 .10 .50 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	.53	0.00	.53	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	24.75	192.00	120.00	130.00	140.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOR	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

[illegible] DATA

STRTQ= -1.00 QRCSN= .05 RTIOR= 2.00

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SUBBASIN AREA AND TC ARE TC= 4.21 AND R= 5.10 [illegible] INTERVALS

UNIT HYDROGRAPH 30 END-OF-PERIOD ORDINATES. LAG= .64 HOURS. CP= .50 VOL= 1.00

30.	109.	203.	282.	339.	313.	279.	244.	118.	97.	
80.	65.	54.	44.	36.	30.	24.	20.	17.	14.	
11.	9.	8.	6.	5.	4.	3.	3.	2.	2.	

HYDROGRAPH ROUTING

ROUTE THROUGH COKEBURG

ISTAQ	ICOMP	ICCON	ITAPE	JPLT	JPRT	INAME	ISTAGE	ITAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1072.	-1

STAGE	1072.00	1073.00	1074.00	1075.00	1076.00	1076.50	1077.00	1078.00	1079.00	1080.00
FLOW	0.00	145.00	405.00	750.00	1135.00	2470.00	3785.00	7185.00	11815.00	16810.00
SURFACE AREA=	0.	7.	9.	15.	20.	23.				
CAPACITY=	0.	37.	61.	235.	357.	421.				
ELEVATION=	1057.	1072.	1075.	1090.	1097.	1100.				

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
1072.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
1075.0	0.0	0.0	0.

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS			
				RATIO 1 .05	RATIO 2 .10	RATIO 3 .50	RATIO 4 1.00
HYDROGRAPH AT	1	.53	1	131.	262.	1311.	2622.
	(	1.37)	(	3.71)(	7.43)(	37.13)(	74.25)(
ROUTED TO	2	.53	1	105.	226.	1255.	2620.
	(	1.37)	(	2.96)(	6.41)(	35.53)(	74.18)(

PLAN 1 ..... INITIAL VALUE SPILLWAY CREST TOP OF DAM

ELEVATION	1072.00	1072.00	1075.30
STORAGE	37.	37.	61.
OUTFLOW	0.	0.	750.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.05	1072.74	0.00	42.	134.	0.00	40.67	0.00
.10	1073.31	0.00	47.	226.	0.00	40.67	0.00
.50	1076.04	1.04	70.	1295.	1.83	40.50	0.00
1.00	1076.56	1.56	75.	2624.	5.17	40.33	0.00

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********
    1                A1       RATIOS OF PMF ROUTED THROUGH THE RESERVOIR AND DOWNSTREAM
    2                A2       DOWNSTREAM CONDITIONS DUE TO OVERTOPPING OF COKEBURG DAM
    3                A3       PLAN 1 ASSUMES BREACH. PLAN 2 ASSUMES NO BREACH (PA-1094)
    4                B    288         0        10         0         0         0         0         0         0         0
    5                B1     5
    6                J      2         1         1
    7                J1    .5
    8                K      0         1                                                 1
    9                K1       INFLOW
   10                M      1         1     0.53                                                                    1
   11                P           24.25       107       120       130       140
   12                T                                                               1.0      0.05
   13                W    0.64      0.50
   14                X    -1.5      -.05       2.0
   15                K      1         2                                                 1
   16                K1       ROUTE THROUGH COKEBURG
   17                Y                                    1         1
   18                Y1     1                                                        -1072        -1
   19                Y4  1072      1073      1074      1075      1076    1076.5      1077      1078      1079      1080
   20                Y5     0       145       405       750      1135      2470      3785      7185     11815     16810
   21                $A     0       7.4       8.5        15        20        23
   22                $E  1057      1072      1075      1090      1097      1100
   23                $$  1072
   24                $D  1075
   25                $B    30       0.5      1057         1      1072    1076.0
   26                $H    30       0.5      1057         1      1072      1085
   27                K      1         3                                                 1
   28                K1       REACH NO. 1
   29                Y                                    1         1
   30                Y1     1
   31                Y6   .06       .05       .06      1135      1180      2000     0.034
   32                Y7     0      1180       200      1160       400      1140       420      1135       680      1135
   33                Y7   700      1140       900      1160      1000      1180
   34                K     99
```

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********************************

RUN  DATE= 81/03/16.
     TIME= 05.52.37.
```

RATIOS OF PMF ROUTED THROUGH THE RESERVOIR AND DOWNSTREAM
DOWNSTREAM CONDITIONS DUE TO OVERTOPPING OF COEBURG DAM
PLAN 1 ASSUMES BREACH, PLAN 2 ASSUMES NO BREACH (PA-1094)

JOB SPECIFICATION

IO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	10	0	0	0	0	0	0	0

	JOPER	NWT	LROPT	TRACE
	5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 2 NRTIO= 1 LRTIO= 1

RTIOS= .50

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	.53	0.00	.53	1.00	0.000	0	2	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	24.25	102.00	120.00	130.00	140.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRES	RTIOR	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= .64 CP= .50 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 4.21 AND R= 5.10 INTERVALS

UNIT HYDROGRAPH 30 END-OF-PERIOD ORDINATES, LAG= .64 HOURS, CP= .50 VOL= 1.00

30.	109.	203.	282.	255.	211.	175.	144.	118.	97.
80.	65.	54.	44.	36.	30.	24.	20.	17.	14.
11.	9.	8.	6.	5.	4.	3.	3.	2.	2.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE THROUGH CUREBURG

ISTAQ	ICOMP	ICON	ITAPE	JRT	JGE	IRES	ISAE	IA
2	1	0	0	1	1	1		

ALL PLANS HAVE SAME ROUTING DATA

GLOSS	CLOSS	AVG	IRES	ISAME	IOPT	LSTR		ITYP
0.0	0.000	0.00	1	1	0	1		1

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ITPAT
1	0	0	0.000	0.00	0.00	-1.00	-1

STAGE	1072.00	1073.00	1074.00	1075.00	1076.00	1077.00	1078.00	1079.00	1080.00	1081.00
FLOW	0.00	145.00	405.00	750.00	1145.00	2470.00	4785.00	7185.00	11815.00	16810.00
SURFACE AREA=	0.	7.	9.	15.	20.	43.				
CAPACITY=	0.	37.	61.	95.	357.	961.				
ELEVATION=	1057.	1072.	1075.	1080.	1087.	1100.				

CREL	SPWID	COQA	EXPW	ELEVL	CAREA	EXPL
1072.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

EXPF	COQA	EXPI	CAREA
1075.0	0.0	0.0	0.

MICROCOMPUTER ROUTING

REACH NO. 1

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	IWAVE	ISTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ALL PEAKS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.0	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QNEIJ	QNOJ	QNCJ	ELQVI	ELMAX	RLNTH	SEL
.0600	.0500	.0600	1135.0	1180.0	2000.	.00400

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1180.00 200.00 1165.00 400.00 1140.00 420.00 1135.00 680.00 1135.00
700.00 1140.00 900.00 1160.00 1000.00 1180.00

STORAGE	0.00	29.30	60.67	95.31	135.09	180.02	230.10	285.33	345.71
771411.24	481.92	557.63	637.40	721.03	808.52	899.88	995.10	1094.19	1197.14
771404.95									
OUTFLOW	0.00	2085.70	6705.41	13739.72	23067.17	34743.68	48863.35	65526.02	84834.76
1968944.16	131809.27	159929.09	191343.68	225772.51	263262.81	303866.09	347636.80	394831.44	444907.92
498525.20									
STAGE	1135.00	1137.37	1139.76	1142.11	1144.47	1146.84	1149.21	1151.58	1153.95
771156.32	1158.68	1161.05	1163.42	1165.79	1168.16	1170.53	1172.89	1175.26	1177.63
771180.00									
FLOW	0.00	2085.70	6705.41	13739.72	23067.17	34743.68	48863.35	65526.02	84834.76
1968944.16	131809.27	159929.09	191343.68	225772.51	263262.81	303866.09	347636.80	394831.44	444907.92
498525.20									

PEAK FLOW AND STORAGE [END-OF-PERIOD] HYDROGRAPH FOR FACILITY [illegible] COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1
				.50
HYDROGRAPH AT	1	.53	1	1311.
	(	1.37)	(	37.13)(
			2	1311.
			(	37.13)(
ROUTED TO	2	.53	1	2673.
	(	1.37)	(	70.03)(
			2	1.35.
			(	35.53)(
ROUTED TO	3	.53	1	2250.
	(	1.37)	(	63.70)(
			2	1104.
			(	33.52)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ••••••••••••••

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1072.00	1072.00	1075.00
STORAGE	37.	37.	61.
OUTFLOW	0.	0.	750.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	1076.05	1.05	70.	2691.	.92	41.15	40.33

PLAN 2 ••••••••••••••

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1072.00	1072.00	1075.00
STORAGE	37.	37.	61.
OUTFLOW	0.	0.	750.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	1076.04	1.04	70.	1255.	1.83	40.50	0.00

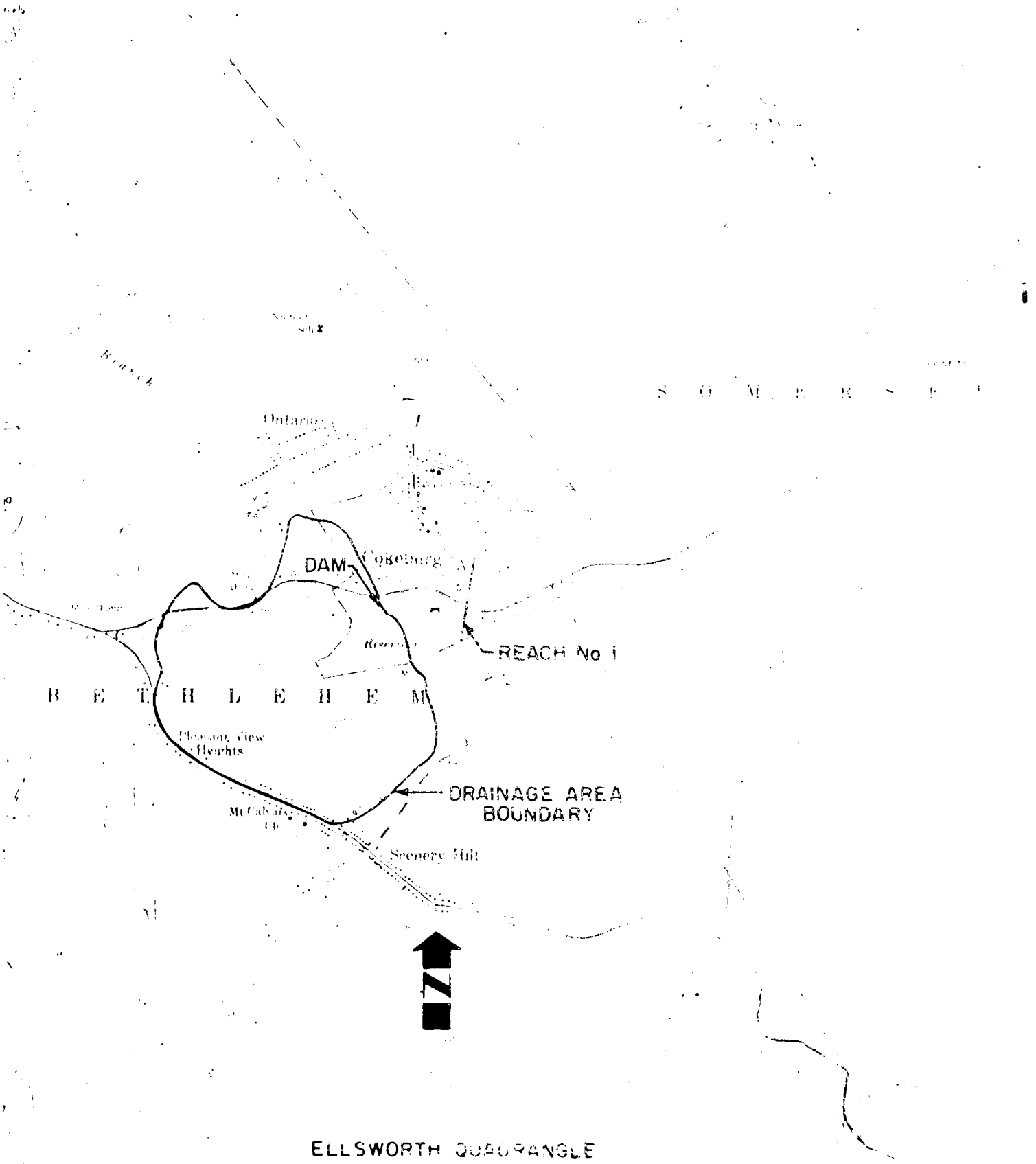
PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	2250.	1137.5	41.17

PLAN 2 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	1186.	1136.3	40.67

APPENDIX E
DRAWINGS

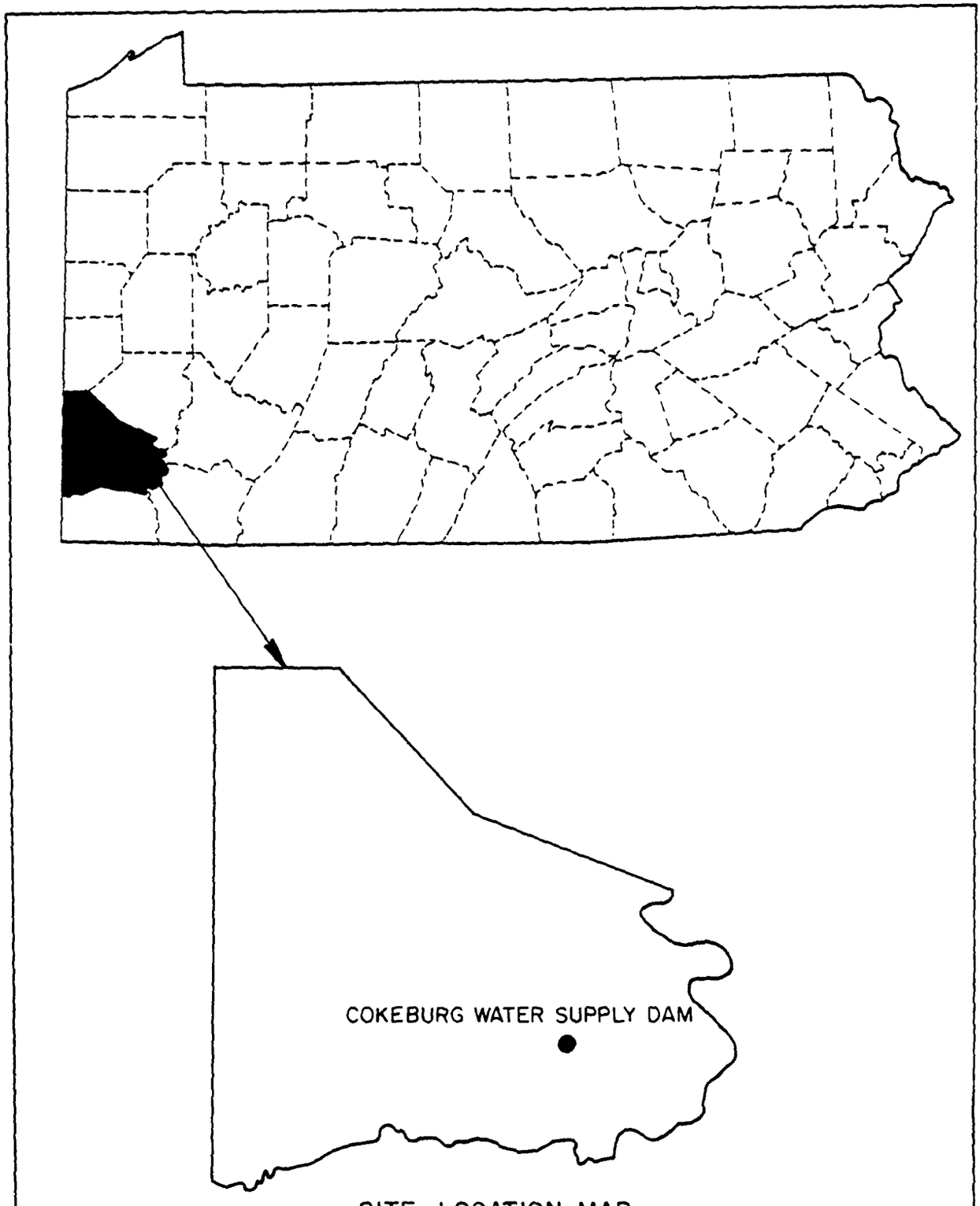


ELLSWORTH QUADRANGLE
7.5 MINUTE SERIES

COKEBURG WATER SUPPLY DAM

DOWNSTREAM EXPOSURE MAP
SCALE 1" = 2000'

R. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS



SITE LOCATION MAP
WASHINGTON COUNTY, PENNSYLVANIA

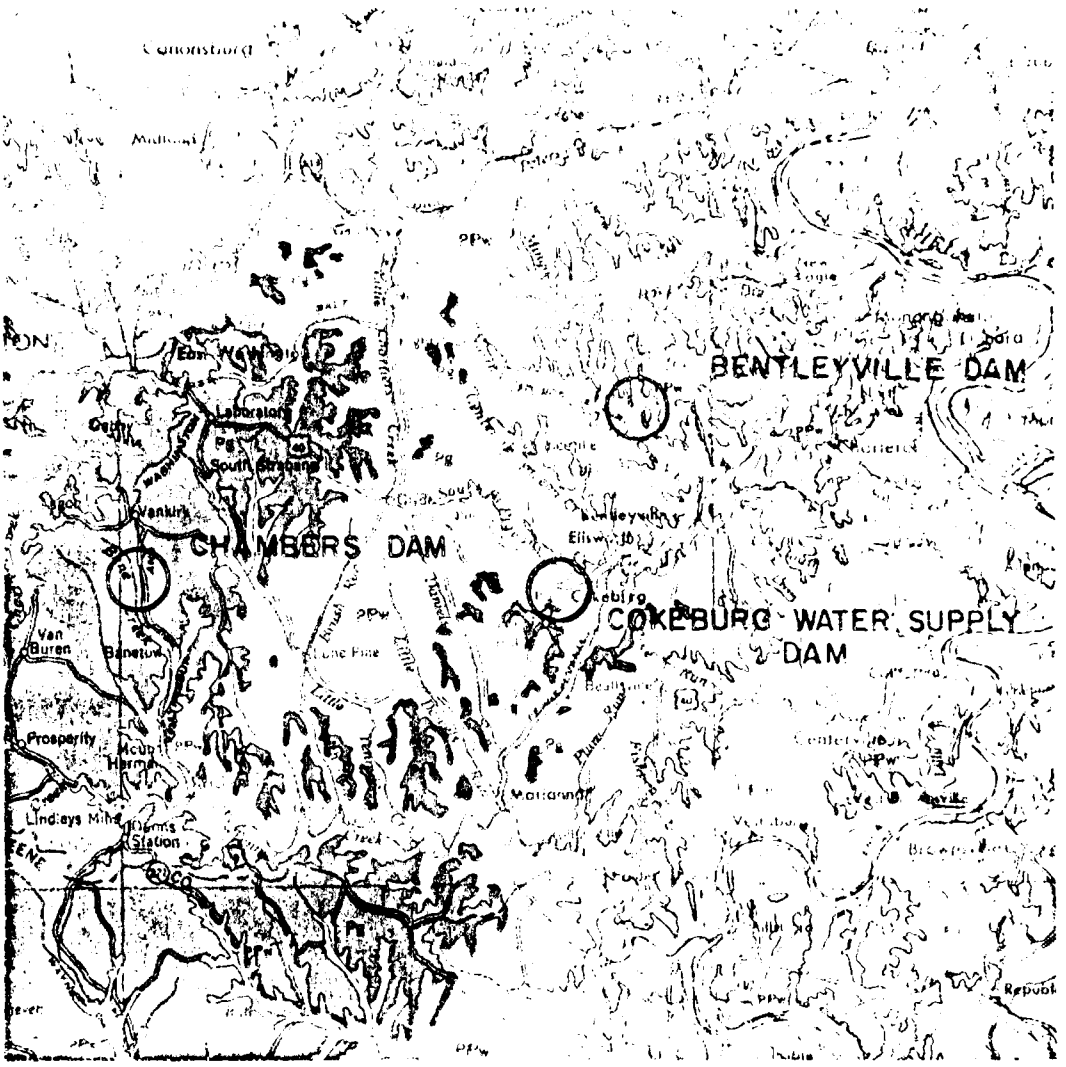
APPENDIX F
GEOLOGY

General Geology

The Cokeburg Water Supply Dam is located in the Pittsburgh Plateaus Section of the Appalachian Plateaus Province. This section typically consists of rounded hills and ridges formed through the erosion by streams of a former plain-like area. In the study area, the ridges are more definite and folds are broader than elsewhere. The sediments are deformed by several sub-parallel secondary folds which are superimposed upon a major spoon-shaped trough of first magnitude in southwestern Pennsylvania and adjacent regions. The axes of these folds trend about N30-50° E, plunging gently southward. The Cokeburg Water Supply Dam lies on the northwest limb of the Waynesburg Syncline, striking to the northeast. The strata dip gently, 1-2°, to the southeast. No major faulting is noted in the area.

The dam is underlain by strata of the lower and middle members of the Waynesburg Formation of Lower Permian and Upper Pennsylvanian Age. This formation is made up of alternating beds of shale and sandstone with many thin coal seams and discontinuous limestone beds. The dam is underlain in part by the Waynesburg A Coal Seam and by argillaceous limestones separated by siltstone and sandstone in places. In general, the Washington Formation is a poor producer of water, with the exception of its basal member, the Waynesburg Sandstone.

The Cokeburg Water Supply Dam is located in the Main Bituminous Coal Field. Principal coal beds which underly the dam are the Waynesburg "A", Waynesburg, and Pittsburgh, in decending order. The Waynesburg "A" coal has a thickness range of 14-28 inches. The Pittsburgh coal is about 440 feet beneath the dam and has been mined out (1964). These beds and several other coal beds of local economic value exist beneath the strata in the vicinity of the dam. Mine dumps are located to the north, east and west of the dam site.



GEOLOGIC MAP OF THE AREA AROUND CHAMBERS DAM, COKEBURG WATER SUPPLY DAM AND BENTLEYVILLE DAM

SCALE 1:250,000

PERMIAN

Pk